7.0 Economic Impact of High-Speed Rail

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This chapter summarizes the findings of the *Economic Impact Analysis and Mode Cost Comparison* study. The chapter covers three main topics:

1. A **modal cost comparison** which examines the cost savings resulting from reduced demand on the existing highway, commercial air and conventional rail modes if high-speed rail were built in California. This analysis provided inputs to the two subsequent analyses.

2. An **economic impact analysis** which analyzes the overall impacts, including both direct and indirect impacts, of high-speed rail system implementation on the California economy.

3. A **benefit cost comparison** which compares the overall benefits of the high-speed rail system to its costs.

To complete this work, it was necessary to select representative technology and alignment alternatives for comparison with the base case (no-build alternative). Although the Commission evaluated a number of high-speed rail route alternatives in the State Route 99 Corridor between Los Angeles and the San Francisco Bay Area, the differences among alignment options are marginal for this statewide analysis. The high-speed rail alignment which produced the highest ridership forecasts was selected for analysis – the other SR-99 alternatives would produce slightly lower conventional mode savings, but overall study conclusions would not change.

Two alignment alternatives were selected: one to represent the basic Los Angeles to Bay Area system and one that included extensions to Sacramento and San Diego. The State Route 99 Base (SR-99 Base) alignment scenario is representative of the system from Los Angeles to the Bay Area. The second high-speed rail alternative extends the representative high-speed rail system to Sacramento via a junction near Stockton, and to San Diego via the LOSSAN route. All three technology groups – High-Speed (HS), Very High Speed (VHS) and Maglev – were analyzed for both alignment alternatives.

7.1 Mode Cost Comparison

The mode cost comparison examined the impact of high-speed rail on the highway, aviation, and conventional rail modes with two primary purposes:

1. To assess the impact on demand for the existing intercity modes if high-speed rail were implemented; and

2. To tabulate the resulting conventional mode cost savings as inputs to the economic impact analysis and benefit/cost comparison.

Actual funding of the conventional modes comes from a variety of sources. Highway funding comes primarily from the State through user fees such as gas taxes, but is augmented by Federal funding (primarily fuel tax) and local funds (often sales tax). Tolls contribute only a minor portion of funding for the California highway system. Passenger rail is funded through fares and State subsidies which mostly comes from fuel taxes. Aviation is funded primarily through fees paid by the airlines (which flow back to the air traveler in higher ticket prices), Federal funding through the Aviation Trust Fund (primarily a ticket surcharge which is not currently being collected), and the air traveler directly (e.g. parking fees, ticket surcharges).

The common theme is that most of California's transportation system is being paid for by public users of the system through fuel taxes and fares. The charges are not often directly related to the benefits provided (e.g. through various forms of congestion pricing for auto and air travel). Nevertheless, it is possible to make an overall assessment of the economic cost savings that would result from high-speed rail and recognize that these benefits primarily flow back to public users of California's transportation network.

The analysis of each of the conventional modes followed a consistent four-step process:

1. Tabulate the number of intercity trips diverted from each mode to high-speed rail for the year 2020, based on the ridership forecasting process documented in Chapter 4.0.

2. Calculate the impact of these diversions on future demand for the existing modes.

3. Determine the relationship of reduced demand to capacity in the existing modes and assess the impact on future construction needs.

4. Estimate the cost savings, including savings in infrastructure investment, associated with reduced demand.

Although a full range of costs were investigated, costs were tabulated only when:

- There was sufficient information available to permit an accurate estimation of the costs; and

- The cost or cost differential was likely to be significant relative to the cost of high-speed rail.

Table 7.1 identifies those cost savings that were quantified by mode.

Table 7.1 Cost Savings Estimated

	Mode		
	Highway	Aviation	Rail
Direct User/Provider			
Operating and Maintenance Costs [(1)]	✓	(1)	✓
Accidents and Insurance	✓	(2)	(2)
External Costs			
Delay Costs [(2)]	✓	✓	(2)
Deferred infrastructure [(2)]	✓	✓	✓
Environmental Mitigation (air pollution) [(3)]	✓	(2)	(2)

Notes: [(1)] Recovered completely by revenue

[(2)] Both delay costs and deferred infrastructure costs were investigated; only one can be used at a time without double-counting.

[(3)] Costs investigated and determined to be insignificant.

Source: Economics Research Associates, (1996).

7.1.1 Highway/Auto Costs

The diversion of trips from the highway or private vehicle mode to high-speed rail results in a decrease in vehicle miles traveled (VMT) and a concomitant reduction of highway user delays, automobile operating costs, accidents and air pollution. Table 7.2 summarizes the highway-related cost savings that could be realized through construction of high-speed rail. Except for auto operating costs, the cost savings accrue to the remaining highway users or to others in the State, but not to former auto users that divert to high-speed rail.

Highway user delay can be considered a surrogate for actual roadway construction that would be required to reduce delay. The reduction in auto user delay is the time saved by all motorists on the highways where high-speed rail has caused a reduction in traffic congestion. The reduction in user delay is calculated with standard traffic volume/capacity relationships and their effect on vehicle speeds. The results indicate that even though the impact on new major highway construction is small, significant economic cost savings can be realized in the highway travel system in California from implementation of high-speed rail. Because the potential for highway user delay or infrastructure cost savings is of particular interest to many, this topic is presented in detail in the following section.

Table 7.2 Highway Cost Savings Summary (Year 2020) ($ 1995 millions)

	L.A. to Bay Area			L.A. to Bay Area + Extensions		
	HS	VHS	Maglev	HS	VHS	Maglev
Highway User Delay	$65	$75	$86	$154	$170	$192
Automobile Operating Costs(1)	$73	$81	$86	$138	$154	$170
Accidents(2)	$55	$61	$65	$104	$116	$127
Air Pollution(3)	$8	$9	$9	$15	$16	$18

Notes: (1) Automobile operating costs were based on standard costs from the Federal Highway Administration (FHWA). The resulting unit cost of $0.16 per vehicle mile includes fuel costs, fuel taxes, maintenance, tires, and 20 percent of the cost of insurance and depreciation. These operating costs are not a net benefit since they must be balanced against the high-speed rail fare paid.

(2) Accident costs were synthesized from a number of sources including results published by the California Energy Commission and the FHWA. A unit cost of $0.12 per vehicle mile was used for this study.

(3) Air pollution costs were synthesized from a number of sources which varied widely in their estimates. A conservative unit cost of $0.05 per vehicle mile was used for this study.

Source: Wilbur Smith Associates.

Highway User Costs

Although high-speed rail diverts relatively few trips from private vehicles compared to other modes, diverted auto trips still comprise between 30 percent and 50 percent of all high-speed rail travel. The Los Angeles-Bay Area high-speed rail system diverts from 2.3 percent (for HS technology) to 2.6 percent (for Maglev technology) of intercity automobile trips. When extensions to San Diego and Sacramento are built, high-speed rail diverts from 5.0 percent (for HS) to 5.7 percent (for Maglev). These results illustrate two factors regarding auto diversions:

1. Adding extensions to San Diego and Sacramento causes a large increase in auto diversions, because the extensions bring in trips from the major auto travel corridors of Los Angeles-San Diego and San Francisco-Sacramento; and

2. The differences among the HS, VHS and Maglev technology groups are minor with respect to auto diversions. This is because travel time or speed is a less important factor when competing with the automobile than when competing with air travel.

The reduction in traffic was assigned to either Interstate 5 (I-5) or SR-99 depending on the origins and destinations of the trips. The demand and capacity relationships were then calculated and plotted graphically for various segments in the intercity highway network in the Corridor:

- I-5 from San Diego to Los Angeles (for analysis of extended high-speed rail system only);
- I-5 from Los Angeles to its junction with SR-99;
- I-5 from SR-99 junction to Stockton;
- SR-99 from its junction with I-5 to Stockton;
- SR-99 from Stockton to Sacramento (with extensions only);
- I-5 from Stockton to Sacramento (with extensions only);
- I-580 from the Bay Area to I-5; and
- I-80 from the Bay Area to Sacramento (with extensions only).

The diversion of trips to high-speed rail is much greater for traffic on I-5 than on SR-99. Assuming that the intersection of demand with capacity would trigger the need for construction of an additional lane on these highways, the presence of high-speed rail would defer the need for this investment for less than one year in all but two cases.

The two exceptions are segments of I-5 between Los Angeles and Bakersfield, and between Bakersfield and Stockton. Since demand is currently much lower than capacity on these two segments, however, widening would not have to occur until well after the year 2020. In other words, high-speed rail probably puts off the need for widening I-5 between Los Angeles and Bakersfield from 2034 to 2038. Between Bakersfield and Stockton, widening I-5 could be put off indefinitely if high-speed rail were implemented.

7.1.2 Aviation Costs

Aviation presents direct competition to high-speed rail at the high end of the travel market, where door-to-door travel time and convenience are extremely important. Ridership forecasts indicate that high-speed rail diverts between 14 and 60 percent of California Corridor air passengers. The impact of that diversion on aviation in the State is subdivided into two categories.

1. Savings in investment in airport **landside** facilities attributable to the diversion of air passengers; and

2. The impact of air passenger diversion on **airside** demand/capacity relationships at California airports and the resulting cost savings.

Airport landside facilities include on-airport facilities outside of the runways that affect airport capacity. These include terminal processing space, gates, taxiways and aprons. Airport airside facilities are defined in this paper as runways and air traffic control investments that directly impact the number of aircraft operations that each airport can handle.

The distinction between landside and airside investment was made because most airports are able to make and fund improvements in landside facilities and the impact of passenger volumes on this investment can be fairly easily quantified. However, major airside expansions (ranging from a new or extended runway to a totally new airport) typically draw major community and environmental opposition and are avoided until no other options are available; the cost savings of high-speed rail in this case are far more difficult to quantify.

The demand/capacity relationships calculated in this study indicate capacity constraints leading to significant future aircraft delay for the three largest airports in California: Los Angeles International (LAX), San Francisco International (SFO) and San Diego Lindbergh (SAN). High-speed rail would help relieve some of the capacity constraints and defer and reduce the cost of other solutions that will have to be explored as delays increase. Key documents and staff were consulted to determine how these major airports plan to cope with future delay.

This analysis indicated that potential solutions for airside congestion fall into three general categories: capacity increases, market responses, or demand management with the possible responses shown below.

- Capacity Increases
  - New runways
  - Runway expansions
  - Air traffic control improvements
  - New airports

- Demand Management
  - Minimum landing fees
  - General aviation surcharge
  - Peak period pricing
  - Gate utilization controls

- Market Responses
  - Larger aircraft
  - Increased load factors
  - Voluntary peak spreading
  - Flights to less congested airports

Capacity increases via new runways and runway extensions are being considered at LAX where a master plan is now underway. However, implementation of these increases is uncertain because of political and environmental opposition. A new runway at SFO would greatly increase capacity but is not being pursued because of major environmental concerns. San Diego will need a new airport in the future and has commissioned a number of site selection studies with limited success.

None of the airports anticipated using demand management strategies such as congestion pricing to reduce the number of flights (particularly by smaller aircraft) during peak periods, partly due to nationwide legal and institutional barriers to such a program (only the New York airports use congestion pricing). In addition, most of the smaller aircraft using the major airports are corporate jets which are not very price sensitive.

The airport operators believe that market responses of the airlines are a more practical approach to avoiding major delays. This is happening now as aircraft get larger, load factors increase and flights are scheduled for less congested times or to less congested airports.

The impacts of aviation delay and solutions to this delay cause adverse economic impacts to air travelers and others in California several ways:

- Delays to passengers and aircraft increase the cost of commerce in the State. This could lead to airlines moving operations and possibly some international gateways out of the State at some point (although the major airports are very protective of international flights).
- Construction of new runways and airports to reduce delay results in adverse environmental impacts (requiring mitigation costs) and potentially decreases property values through noise and other impacts.
- Travel demand management (either imposed or voluntary) to reduce delay exacts an economic impact in the form of traveler inconvenience (flights to inconvenient airports or at less convenient times).

Because the potential responses to aviation delay are so varied and inconsistent, it is difficult to measure the above-listed types of economic impact directly. Instead, quantification of reduction in delay costs provides a consistent and defensible means of accounting for economic impacts, regardless of the actual response to delay. Delay costs fall on all air passengers who must wait and on airlines that have increased fuel and personnel costs.

Note that the ridership forecasts did not account for the increases in aviation delay that may be encountered in future scenarios.[1] Unless accommodated through other demand reductions or capacity improvements, this factor would increase the travel time benefits of high-speed rail as the number of high-speed rail passengers would increase.

Table 7.3 summarizes potential aviation cost savings attributable to high-speed rail in the year 2020. The cost savings are divided into the two major categories previously discussed: (1) landside investment and (2) airside delay.

The delay savings in particular are significant and may be considered a surrogate for the deferred costs for other responses to aviation delay. Such responses include construction of new runways and air traffic control systems, slotting of flights into less convenient times, and the inability to accommodate longer distance flights.[2]

[1]A sensitivity analysis of the ridership forecasts will address this issue prior to finalization of this report.

[2]Long distance flights provide greater economic benefits to the State.

Table 7.3 Aviation Cost Savings Summary (Year 2020) ($ 1995 millions)

	L.A. to Bay Area			L.A. to Bay Area + Extensions		
	HS	VHS	Maglev	HS	VHS	Maglev
Landside Investment	$19	$33	$46	$31	$48	$63
Airside Delay Cost Savings						
Passenger Time	$146	$224	$306	$286	$389	$520
Aircraft Operations	$109	$164	$219	$229	$307	$407

Source: Wilbur Smith Associates.

7.1.3 Conventional Rail Investment

The impact of high-speed rail on conventional intercity rail service is quite different than that on air and highway travel. Rail passengers comprise a very small proportion of intercity trips (about 1 percent in the Corridor). In addition, the level of service and funding for rail is much more directly controlled by the State. This means that although market forces impact future rail ridership in the Corridor, the State is better able to dictate future investment policy in rail than in the other two intercity modes.

In the absence of a high-speed rail system, passenger volumes on each of California's three routes should more than double by 2020. Assuming that levels of efficiency (average passengers per train trip) will increase slightly over time, the number of round trips on the *San Diegan* line could increase to as many as 18 per day in year 2020. Seven daily *San Joaquin* round trips would be required to accommodate the projected passengers, and *Capitol Corridor* service would need to increase to six intercity round trips.

If the high-speed rail system is constructed, a significant number of passengers would choose the more attractive high-speed service over conventional rail, particularly for longer distance trips. High-speed rail would, in effect, replace a certain number of the conventional trains. The daily number of conventional *San Diegan* trains required in 2020 would be reduced to seven, the seven *San Joaquins* to one or two trains (and possibly total elimination), and the six *Capitols* to two or three trains.

Once a decision is made to construct a high-speed system, the rate of investment in a conventional intercity program undoubtedly would drop because of competition for funds, and because the level of conventional service following completion of the high-speed system would decline. The remaining conventional rail services (including growing commute rail services over the same trackage) would require at least maintenance-level support for track, replacement equipment, stations, and service facilities.

Table 7.4 summarizes the expected capital and operating cost savings in conventional rail.

Table 7.4 Conventional Rail Cost Savings Summary (Year 2020) Reduced Service vs. Discontinuance ($ 1995 millions)

	L.A. to Bay Area		L.A. to Bay Area + Extensions	
	Continue Reduced Conventional Service	Discontinue San Joaquin Conventional Service	Continue Reduced Conventional Service	Discontinue San Joaquin Capitol and San Diego Service
HS	$38	$67	$63	$132
VHS	$38	$67	$66	$132
Maglev	$38	$67	$71	$132

Note: Savings shown in this table represent the amount of reduced capital and net operating costs compared to projected amounts required for full conventional rail service in 2020 if no high-speed rail service was operated.

Source: Wilbur Smith Associates

7.2 Economic Impact

The economic impact analysis compared the overall and component impacts of two high-speed rail technology alternatives (VHS and Maglev) on the California economy. A detailed simulation and forecasting model of the California economy was procured from Regional Economic Models, Inc. (REMI) to perform this analysis. The REMI model was initially used to establish a base case forecast of the California economy to the year 2020. The different high-speed rail investment alternatives were then compared to this base case forecast to determine economic impact.

Established in 1980, the REMI model is designed to estimate the impact of major investments or policy changes on the national, state, or regional economy. The basic procedures followed by the REMI model are as follows:

- The model starts with inter-industry relationships in the United States economy and the projected changes of those relationships over time.
- The model was then adjusted to reflect California's industrial concentration in the different sectors and the proportion of local demand which is produced in California.
- The model calculates of the amount of labor and capital required to produce the State's output.

- The model predicts population and labor force availability and calculates wages, prices, and profits.
- The model then uses these factors to estimate California's competitiveness and labor force migration to and from the State.

7.2.1 Overview of the California Economy

With a gross regional product (GRP) in the vicinity of one trillion dollars, California constitutes approximately one-seventh of the United States economy. If California were a nation, its economy would rank eighth in the world and be comparable in size to Italy or Brazil. By 2020, California's GRP is projected to exceed $1.4 trillion, and the State could have the fifth or sixth largest economy in the world. To have a measurable impact on this economy, any single investment decision must be quite substantial.

California's population has grown from 23.8 million in 1980 to 32.0 million in 1995, an increase of 8.2 million. In 1995, just under 30.2 million resided in counties defined to be within the high-speed rail corridor. Of the State's increase over the past 15 years, 60 percent was in Southern California and 19 percent was in the Central Valley. Between 1980 and 1995, the Central Valley was the fastest growing region in California.

Employment growth patterns mirrored that of population growth. California gained 4.2 million jobs over the past 15 years. Fifty-four percent of the job gain was in Southern California and 16 percent was in the Central Valley. The annual rate of employment increase in the Central Valley was 2.5 percent, considerably faster than the statewide and high-speed rail corridor average of 1.9 percent.

California's population is forecast to increase to 48.8 million by the year 2020. Southern California, facilitated in part by the rapid development of the Antelope Valley, will continue to dominate by capturing nearly 58 percent of statewide population growth. During this period, however, the Central Valley will continue to be the fastest growing region in California. Over the next 25 years, the Central Valley is projected to have an annual population growth rate of 2.5 percent, compared to 1.6 percent for the State as a whole. Population in the Central Valley will increase from 4.7 million in 1995 to 8.8 million by 2020. This 4.1 million increase will account for one-fourth of the State's incremental population growth.

The State will gain 6.2 million employees by 2020, of which approximately one-fourth will be in the Central Valley. Between 1995 and 2020, the Central Valley and Antelope Valley combined will account for approximately 30 percent of statewide employment growth.

7.2.2 Summary of Economic Impact Findings

The construction and operations of the high-speed rail system, using either steel wheel or magnetic levitation technology, generates a positive impact on the California economy through the year 2020. System construction provides a major positive impact on employment during peak years in the 2000 to 2008 period, and lower average housing cost stimulates economic growth during the 2010 to 2020 period. However, these positive impacts are somewhat offset by the negative influence of the tax increase required to fund the system and some reduction in employment in the air and conventional rail modes.

Because of these conflicting influences, the employment impact fluctuates widely in the early years of system construction and operation. However, the longer term impact is likely to become increasingly positive as high-speed rail operation improves California's competitiveness. Figure 7.1 presents a comparison of the overall impact on employment of the VHS and Maglev technology alternatives to the base case for the period 1998 to 2020. Cumulatively, construction of a VHS system will create 314,000 person years of employment during the construction period; construction of a Maglev system will create 450,000 person years of employment. Moreover, high-speed rail significantly accelerates employment growth in the Central Valley where unemployment rates have been two to three times higher than in the major metropolitan areas.

Another indicator of economic impact is the change in the State's Gross Regional Product (GRP). The development and operations of the high-speed rail system substantially increase the California GRP over the base case alternative. The change in GRP from the base case fluctuates from year to year between 1998, which is the initial year of the tax increase, and 2012. This fluctuation is due to the conflicting influences of the tax and the construction impacts. After 2020, the impacts are positive and steadily increasing as the added mobility benefits of the system come into play (see Figure 7.2).

The cumulative net GRP increase from 1998 through 2020, expressed in constant 1996 dollars without a discount rate, is $7.7 billion for the VHS system and $10.3 billion for the Maglev system. Given that California's GRP is higher and climbs steadily while population and employment remain essentially unchanged in the year 2020, the State economy is more productive and the average Californian has more income with high-speed rail. Furthermore, the benefits of high-speed rail would continue to increase beyond the year 2020.

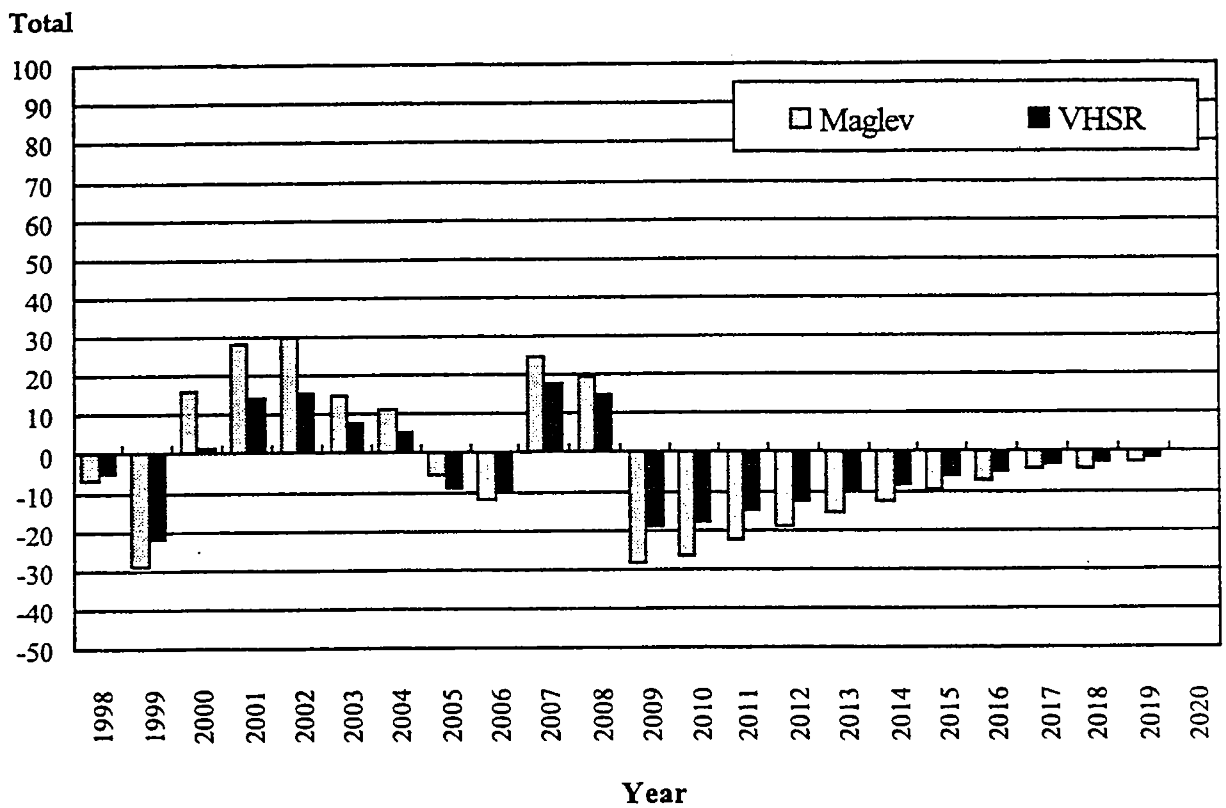
7.2.3 The Economic Impact of Key Variables

Based on the detailed analysis, three sets of variables emerged as having the most significant impact on the California economy. These are discussed below:

High-Speed Rail Construction, Procurement and Operations

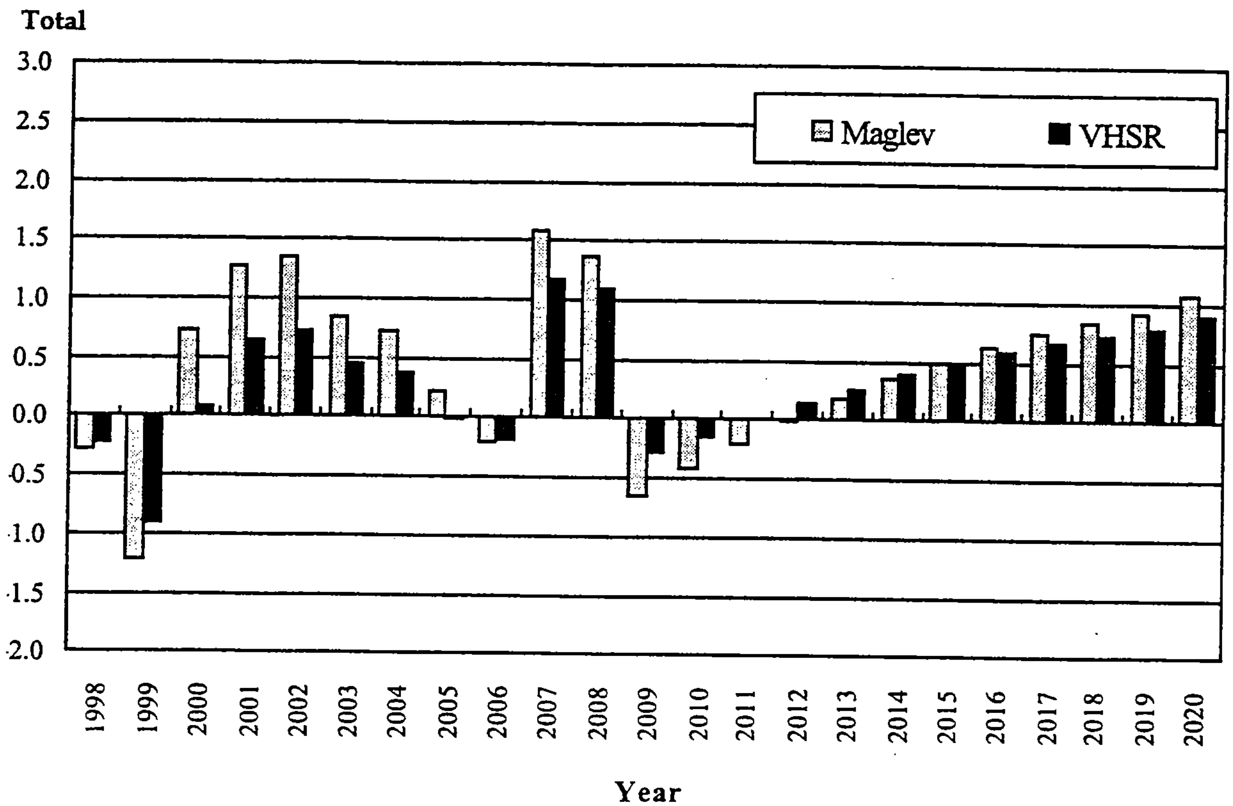
The construction of any $18 to $25 billion dollar project will have an impact on the State economy. As shown in Figure 7.3 construction of the high-speed rail system will have two peaks. The first reflects the construction of the basic system from Los Angeles to San Francisco during the 2000 to 2005 period; the second is the construction of the extensions to San Diego and Sacramento during the 2006 through 2008 period. During these peak years, the gain in number of direct and indirect jobs is nearly 70,000.

Figure 7.1 Overall Impact of the Alternatives Compared to Base Case
Total Number of Jobs Gained, 1998-2020



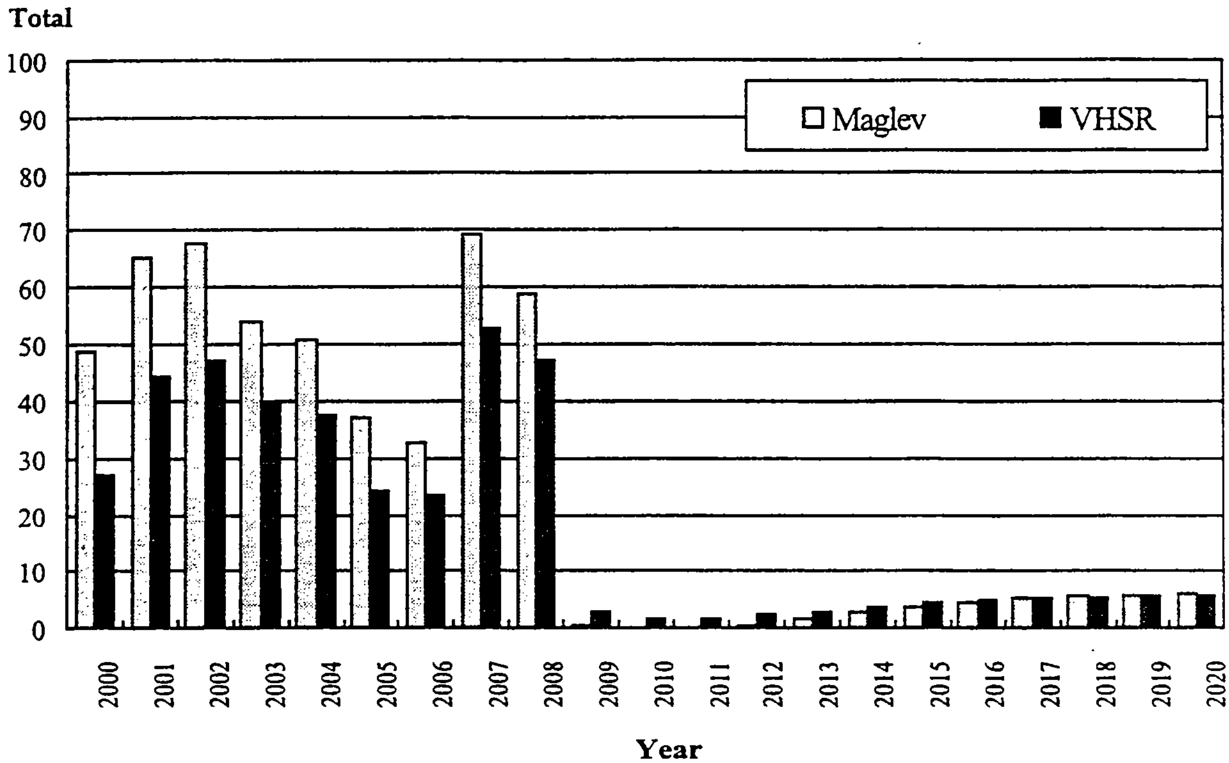
Source: ERA using REMI.

Figure 7.2 Net Overall Impact of the Alternatives Compared to Base Case
CA Gross Regional Product, 1998-2020



Source: ERA using REMI.

Figure 7.3 HSR System Construction, Procurement, and Operations Total Number of Jobs Gained, 2000 - 2020



Source: ERA using REMI.

Effect of Tax Increase

Any tax increase, if viewed in isolation without considering the investments made with the revenue collected, slows economic growth and decreases employment. If the system were funded with a gas tax increase, the 6 cent per gallon increase required for the VHS system would decrease employment in the State by approximately 35,000 per year. The 8 cent per gallon increase for a Maglev system would decrease employment by nearly 50,000 per year.

Equivalent revenue could also be raised by a 1/4 cent statewide sales tax for VHS or a 3/8 cent tax increase for Maglev. There are two main differences between a fuel tax geared to the amount of fuel consumption and a sales tax:

- A sales tax is likely to keep pace with California's population and income growth while a fuel tax may not, because of the increasing fuel efficiency of new automobiles and the possible growing use of alternative fuel vehicles such as electric vehicles.

- A sales tax reduces consumer disposable income and spending directly. A fuel tax that raises the same amount of money receives approximately 85 percent of the revenue from consumers and the other 15 percent from the trucking industry. However, the higher cost of trucking has a secondary effect on many sectors of the California economy.

The faster sales tax revenue growth translates into more direct revenue for high-speed rail development but also greater adverse impact on California job growth. However, if the two revenue streams were made equal, the fuel tax has the more adverse impact on California job growth. When compared to the base case alternative, the 2020 job loss for the Maglev alternative is 37,200 for the sales tax scenario and 49,100 for the fuel tax scenario. For the same amount of revenue raised, the fuel tax has more adverse economic impact on California job growth because the resulting higher operating costs for the trucking industry have a secondary cost impact on many sectors of the economy. Thus, if a per gallon fuel tax is used to fund high-speed rail, the State may wish to exempt diesel fuel.

The Reduction in Corridor Average Housing Cost

During the past 15 years, high housing costs have been the single most significant factor adversely affecting the competitiveness of California. Even a slight reduction in average housing cost will increase California's attractiveness for both employees and employers. Several of California's largest home builders interviewed by ERA have indicated that they would give preference to communities served by high-speed rail stations in the construction of entry level single family homes. The high-speed rail systems will tend to induce additional residential construction in communities. The Antelope Valley and San Joaquin and Stanislaus Counties, for example, are able to provide lower land and labor costs and yet be within commuting reach of major metropolitan areas such as the Los Angeles basin or the San Francisco Bay Area. It is the expansion of these metropolitan areas which will drive California's economic growth over the next 25 years.

This additional residential construction in the Central Valley and the Antelope Valley will accelerate population growth in these lower housing cost areas. This, in turn, will tend to lower average housing cost in the entire high-speed rail corridor. The lower average housing cost increases California's attractiveness to workers and thus to employers because they are able to pay lower wages.

The expected seven to 10 percent incremental population growth in the Central Valley and Antelope Valley between 1995 and 2020 results in a slight reduction in housing costs throughout the high-speed rail corridor. While the actual percent reduction in housing costs is very small (under 0.4 percent for VHS and about 0.5 percent for Maglev), the competitiveness of the California economy relative to other states is very sensitive to housing cost. High-speed rail's influence in this area is one of its most important contributions to California's long term economic growth.

7.2.4 Impact by Industry Section

Agriculture

The high-speed rail system represents a mixed blessing to the agricultural sector. The high-speed rail-induced acceleration in population and employment growth in the Central Valley will increase the economic pressure for the conversion of agricultural lands to urban and suburban use. However, the 3 to 5 percent additional total population expected in the Central Valley by 2020 can be accommodated easily by improved local government land-use planning. By encouraging somewhat higher urban and suburban densities and adopting policies to protect prime agricultural areas, the additional pressure on the agricultural sector can be contained.

Depending upon the efficiency of the interface between the high-speed rail system and major international airports, the new high-speed rail system could also stimulate the export of high value agricultural products grown in the Central Valley to distant markets. An example would be the increase in shipment of premium-quality and individually-packed fruits by air transport from San Francisco or Los Angeles International Airports to Japan.

Manufacturing

The high-speed rail system does not have a major impact on California's manufacturing sector. The gas tax or sales tax increase would tend to impede the growth of this sector during the earlier years of its implementation. This negative impact is offset by the procurement of the rail cars which are only 3 percent (Maglev) to 5 percent (VHS) of the total system capital cost. In the longer term, high-speed rail will induce residential construction in lower cost areas, such as the Central Valley and the Antelope Valley. The increased housing construction in these relatively more affordable areas will lower overall high-speed rail corridor housing cost. This will, in turn, increase the competitive position of California relative to other states and lead to growth of all sectors, including manufacturing.

Several California high technology firms indicated that having a high-speed rail system serving the Highway 99 Corridor would not necessarily increase their likelihood of locating branch plants in the Central Valley. Some firms use their corporate aircraft to travel, others cited their increasing reliance on telecommunications, and still others indicated their concern with the quality and training of the Central Valley labor force for high-technology production.

High Technology Sector

Although the impact on manufacturing jobs is likely to be modest, the construction and procurement of high-speed rail will have a significant impact on California's higher technology sectors. The procurement of a Maglev system will add an estimated 1,700 jobs per year during the peak production years 2000 through 2005. However, the signals and communications, engineering services and program implementation components add an average of 11,600 jobs per year over this period. These jobs are tabulated within the construction sector. During the peak construction and train production period of 2000 through 2005, California will add an average of 13,300 higher-technology jobs and three-quarters of a billion dollars in additional GRP per year over the base case. Note, however, that a large majority of these more sophisticated jobs are in the service rather than the manufacturing sector.

Construction

The construction sector benefits in many ways from the high-speed rail system. Clearly, building this multi-billion dollar system would provide many opportunities for businesses and employees in this sector. Construction of the extended VHS system produces 314,000 person years of employment, with 450,000 for the Maglev system. The construction of the high-speed rail system will also induce an acceleration in time of commercial construction around the stations and residential construction in the communities served by high-speed rail. In addition, the increase in California's competitiveness resulting from slightly lower average housing costs will stimulate in-migration and additional construction of all types over the long term.

Finance, Insurance, and Real Estate

This sector actually experiences the largest relative impact within the California economy. Major owners of real estate around the stations and financiers participating in system construction will likely receive the greatest benefits. Real estate developers, brokers, and financiers active in the high-speed rail corridor should also benefit.

Wholesale and Retail Trade

The high-speed rail impact on this sector is essentially in proportion to its impact on the California economy as a whole. Growth of the wholesale and retail trade sectors are essentially functions of population and income growth. Because of somewhat higher population growth, retail and wholesale businesses in the Central Valley will benefit.

Services

The services sector derives three types of benefits from the development of the high-speed rail system. First, the more specialized professional services firms located in the major urban centers will be able to increase their market reach into the smaller communities which are not able to support such professionals. For example, a lawyer with a specialty practice based in downtown Los Angeles will better be able to serve clients in San Diego, Bakersfield and Fresno.

Second, tourist establishments located in desirable destinations that are near high-speed rail stations will experience an increase in business. Hotels, restaurants, and the convention center in downtown San Diego should experience a substantial increase in performance because of their waterfront location and high-speed rail station proximity. If there is an Anaheim station, visitor attractions like Disneyland and Knotts Berry Farm will see an increase in attendance due to high-speed rail. The Music Center, Museum of Modern Art, Chinatown, Dodger Stadium, Little Tokyo and Olivera Street areas of central Los Angeles should all experience additional patronage due to high-speed rail service to Union Station. The Magic Mountain theme park would benefit from a Santa Clarita station. Theaters, restaurants, hotels, retail shops and the new Giants baseball stadium will benefit from a San Francisco high-speed rail station.

Third, establishments which provide personal or business services in areas such as the Central Valley and Antelope Valley will experience an increase in business due to the acceleration in population and employment growth induced by high-speed rail service.

Government

Development of the high-speed rail system will cause some growth in state and local government employment. The formation of a new entity, state agency, or joint powers board will probably be required to oversee the construction, operation, and maintenance of the system. Local government employment in the Central Valley and the Antelope Valley will likely expand to keep pace with a higher rate of population growth.

7.2.5 Land Related Impacts

Station Area Development Impacts

The amount and value of new development expected to occur within one-half mile of selected high-speed rail stations was analyzed over the year 2000 to 2020 time horizon. For the area within one-half mile of the selected stations, a total of $7.7 billion in new real estate development is expected during the 20-year time span from 2000 to 2020. Of this total, an estimated 22 to 27 percent or $1.7 to $2.0 billion can be attributed to the presence of the high-speed rail station. The development impact considers both the time period in anticipation of high-speed rail system completion and the period after completion.

The highest dollar value impact will be at the major downtown stations. Since these downtown locations would attract a considerable amount of land development even without high-speed rail, the high-speed rail percentage contribution may be fairly small. The absolute dollar value impact, however, will be considerable. High-speed rail will add strength to downtowns which are viewed favorably by the development community. While a high-speed rail station built in isolation will not be sufficient to reverse a decaying downtown area, high-speed rail can be used by local government as a catalyst to stimulate a comprehensive urban area revitalization program.

Station Area Land Value Effects

The high-speed rail system will increase land values around all station types. Mid-size city centers, particularly those with express or semi-express service would have land value increases of up to 20 percent, due to comparatively lower land costs and the ability to provide infrastructure and access to support high-speed rail. Generally, the percentage increase in land values in major city centers would be less than mid-size cities due to a largely developed area and less land available for high-impact station area development. Rural or exurban station areas, particularly those in communities which are within commute distance of major urban employment centers, would have the largest increase in land values (up to 45 percent).

Corridor Land Value Effects Outside Station Areas

Land values within 1,000 feet of high-speed rail alignments, but outside the station influence areas, would remain neutral or decrease under both strong and weak economic influences. Within major and mid-size city corridors land value effects would be typically minor (neutral or negative 5 percent), as most alignments proposed for high-speed rail are within existing intercity, commuter or freight rail alignments. Suburban areas could experience land value decreases of up to 10 percent, particularly for new alignments that are not currently in active rail corridors. Rural areas would experience the most negative impacts because new high-speed rail alignments could restrict the cross movement of farm equipment, goods, and people. Also new alignments may parcelize farmland and diminish access to parcels for crop production. The lower cost "new" alignment alternative through the Central Valley, which would have fewer grade separated crossings, would tend to have a greater adverse impact on rural area land values.

Construction Land Value Effects

Construction of the high-speed rail system could have a temporary negative impact on land values of property adjacent to the alignment. Construction along new rail alignments is expected to have the largest negative impact on land values, while construction along existing rail alignments will not impact land values in most cases. Residential land uses along the alignment are more likely to be affected by high-speed rail construction than industrial uses. Construction impacts on new alignments would be more pronounced if an elevated or below-grade alignment is required and heavy construction equipment is used for extended periods.

7.2.6 Policy Implications

Super Commute Linkage

Because California's competitiveness is very sensitive to housing cost, the economic analysis indicates that one of the important economic contribution of the high-speed rail system is its ability to strengthen the linkage between expanding metropolitan areas, such as the Los Angeles basin, the San Francisco/Oakland Bay Area, and Silicon Valley, and the communities that offer more affordable housing. For people living in these lower-cost communities in the Central Valley or the Antelope Valley, the linkage does not necessarily imply a daily commute on high-speed rail. Rather, the linkage means having a commute option and more convenient access to the specialized services, recreation, and entertainment opportunities offered by the major urban centers.

More than one-half of California's growth over the next 25 years will be in Southern California. With recovery from the severe early 1990s recession, the Los Angeles basin economy will need to expand. Improved access to the lower cost housing stock provided by the communities in the Antelope Valley facilitates the expansion of the Southern California economy. A similar situation occurs in Northern California with important linkages between the Central Valley and employment in the Bay Area.

As the importance of serving the long-haul commute market becomes more apparent, the high-speed rail connection with the urban rapid transit systems of the major metropolitan areas becomes more critical as well. Convenient transfers between high-speed rail and Metro Rail at Union Station in downtown Los Angeles and with BART in downtown San Francisco are of paramount importance.

Major Urban Centers

Over half of the incremental employment induced by high-speed rail is in the finance, insurance and real estate (FIRE) and services sectors. The firms in these sectors tend to be concentrated in the major urban centers. Providing high-speed rail service to California's major urban centers, such as the downtowns of Los Angeles, San Francisco, San Diego, and Sacramento, is therefore very important if California is to fully collect the economic returns of this major investment. This issue can be viewed from two perspectives:

- The highly specialized service firms in fields such as law, engineering, accounting, architecture and management consulting located in these major downtowns will benefit from improved market reach into the rapidly growing communities of the Central Valley. The entertainment and recreation establishments in these urban centers would receive similar benefit. The greater market reach provided by high-speed rail strengthens these downtowns.

- The residents of Central Valley and Antelope Valley communities will benefit from the improved access to services, retail, entertainment, recreation, and public assembly venues available in these major urban centers. These would include fine restaurants, more specialized shops, theaters, performing arts facilities, museums, major league sports attractions, and even ethnic commercial districts. The high-speed rail access improves the quality of life for residents in these lower-cost communities and thereby improves California's ability to compete against states that promote their cost advantage.

Catalyst for Downtown Area Revitalization

Many of California's cities have experienced deterioration of their urban cores as the new growth moved to the periphery. In most cases, a high-speed rail station built in isolation will not generate sufficient momentum to reverse a downtown's downward spiral. However, local governments will have the opportunity to use the arrival of high-speed rail, as part of a comprehensive revitalization program, to stimulate private sector investment in their core areas.

Central Valley Land Use Planning

The State's investment in high-speed rail and its selection of the SR-99 Corridor could increase the pressures for conversion of agricultural lands in the Central Valley to urban and suburban use by encouraging and accelerating spread-out patterns of growth. Continuation of this trend could encroach upon productive farmland and fragile open spaces. The urban encroachment into highly productive agricultural areas can be contained by the implementation of more rigorous land use plans and policies. City and county governments in the Central Valley could use the arrival of high-speed rail as an opportunity to create updated general plans and land use policies which support more land efficient and rail-compatible urban development patterns.

The impact of high-speed rail on development in the Central Valley will depend largely on the degree of local and regional advanced, strategic planning that takes place. Most important are establishing a vision, creating an economic development strategy, phasing planning, introducing development incentives, and establishing a conducive institutional framework. In addition to establishing a vision and an economic development strategy for the Central Valley Corridor, strategic planning should include putting into place implementation tools (i.e. land assembly assistance and tax benefits) that would entice and encourage the type of development desired.

High-speed Train Manufacturing

The manufacturing of high-speed rail train sets does not appear to offer a major industrial development opportunity for California. The reasons are summarized below:

- The cost of the train sets are a minor portion, (3 percent for Maglev and 5 percent for VHS Technology), of total high-speed rail system capital cost.

- Manufacturing of very high-speed rail steel wheel train sets is a mature technology which would require substantial cost and time for California to replicate. A "buy California only" approach would substantially increase train set procurement cost and the reliability risks associated with a new product.

- While an exact parallel is not true for Maglev technology, California will need to invest multiple millions of dollars in a Maglev demonstration project to be able to catapult over the knowledge already acquired by the Germans and the Japanese. The American Maglev Association at one time estimated the United States investment needed to be in the range of $750 to $800 million dollars. Even if California were able to gain first mover advantages in Maglev train system manufacturing with a high level of investment, the downstream market opportunities are very uncertain.

- The existing rail industry in the United States is scattered in many different states through the East Coast and the Mid West. California does not have the competitive advantage of established strength in this industry. Major subsidies, or protectionist policies which translate into higher procurement cost, would likely be required to foster the development of this industry within California.

- The California economy is evolving away from manufacturing and toward services and information technology, likely growth sectors for the next 20 years. Policies directing state investment to high-speed rail equipment manufacturing would not amplify the current market based evolution of the California economy.

Although the impact on manufacturing jobs is likely to be modest, other intermediate input sectors will benefit, particularly those providing engineering, scientific and other professional services. The total jobs which are likely to accrue from these sectors and from the sectors providing intermediate inputs to train set manufacturing are projected to average 13,300 jobs annually between 2000 and 2005. This increase would not only alleviate California's recent job losses in aerospace and related industries but would also provide additional support in the development of California's high-technology industries.

Integration of the Central Valley into High Tech California

As California rebounds from the recession of the early 1990s, the industries leading the recovery are telecommunications, high-technology manufacturing, computer software, multimedia, entertainment, business and professional services, and biotechnology. These industries will be the growth industries of the early twenty-first century. An economy whose competitive advantage is based upon knowledge-oriented services requires a well educated labor force. The Central Valley needs educational facilities, such as the proposed UC Merced campus, to produce such a labor force. The Valley also needs communities that are able to offer a high quality of living at a reasonable cost to retain this labor force. The high-speed rail system improves the ability of the Central Valley communities to provide that combination by increasing their access to metropolitan areas which offer employment and entertainment opportunities.

Accelerating Job Growth Where It is Most Needed

Very possibly, high-speed rail's most important economic contribution to California is its ability to accelerate employment growth in the Central Valley, where unemployment rates have been two to three times that of the major metropolitan areas.

7.3 Benefit Cost Comparison

The bottom line assessment of any major transportation investment is whether it is economically feasible. This does not mean that the project must be financially self-sustaining. Rather, the estimated and quantifiable economic benefits of the projects need to exceed its estimated and quantifiable costs. If the benefit/cost results exceed 1.0, then the high-speed rail project should be viewed as a prudent investment in California's economic future.

Major transportation projects such as high-speed rail can create economic value in either of two ways:

1. **Transportation Efficiency Benefits** – Transportation efficiencies resulting from the introduction of high-speed rail in a corridor are true benefits to California and to the nation. The time savings, greater safety, greater comfort, and reduced costs experienced by travelers is not offset by losses to other people. These types of savings are equivalent to income by making resources available for other purposes. This type of economic value, or benefit, is included in this analysis as a net economic benefit attributable to high-speed rail.

2. **Economic Development Impacts** – A new high-speed rail system can encourage economic activity to shift to the high-speed rail corridor, increasing employment and net income.

It is important to distinguish between these two economic effects of high-speed rail development. Efficiency improvements are net economic gains whose benefits are not offset by losses to parties outside the high-speed rail corridor. In contrast, resources attracted to the high-speed rail corridor may be, in essence, transferred from other locations in the United States These transfers are not necessarily net gains to the nation although they might be net gains to California.

A clear distinction is drawn between these two types of economic effects throughout the benefit/cost analysis. Whether the transfer of economic activity is viewed as positive or negative depends on the geographic perspective taken.

In any case, care is taken to not double count these benefits and impacts. If a transportation benefit (such as a travel time savings) is the cause of an economic development impact (a job, for example), then only the transportation benefit is included as a net benefit in the benefit/cost analysis.

To determine if high-speed rail has economic merit, all quantifiable high-speed rail costs and all quantifiable economic costs and benefits were tabulated. These include the following:

- **Costs** – All of the costs of high-speed rail implementation – planning, design, right-of-way acquisition, construction, etc. (see Table 7.5).

- **Benefits** – Include the following (see Table 7.6):

  - **Savings in Other Modes** – The reduced costs of using and operating the highway, air, and conventional rail modes due to diversion of passenger traffic from those modes to high-speed rail. These savings are presented in the first section of this chapter.

- **High-Speed Rail User Benefits** – The economic benefits that accrue to those who choose to use the high-speed rail system (also referred to as "consumer surplus", see following section).

- **Operating Surplus**-The net difference between annual high-speed rail operating and maintenance costs and annual high-speed rail operating revenues, including passenger, freight and concession revenues.

Only true net impacts, with no double counting of benefits and excluding transfers from one area or group of people to another, were included in the tabulation.

Table 7.5 Costs Used in Benefit-Cost Calculations ($ 1996 billion)

	Basic System	Extensions	Total
VHS	$11.9	$6.3	$18.2
Maglev	$16.8	$8.4	$25.5

Source: Wilbur Smith Associates.

Table 7.6 Net Transportation Efficiency Benefits (Year 2020) ($ 1996 million)

	Annual Year 2020 Benefits			
	Basic System LA- SF		With Extensions	
	VHSR	Maglev	VHSR	Maglev
Other Mode Savings[a]				
Highway	$145	$160	$302	$337
Aviation	$421	$571	$744	$990
Conventional Rail	$38	$38	$66	$71
High-Speed Rail User Benefits[b]	$249	$433	$515	$835
High-Speed Rail Operating Surplus[c]	$185	$338	$425	$671
Total Benefits	$1,038	$1,540	$2,052	$2,904

Sources: a) Wilbur Smith Associates.
b) Charles River Associates.
c) Wilbur Smith Associates, Parsons Brinkerhoff, Charles River Associates, Public Financial Management.

7.3.1 High-Speed Rail User Benefits

User benefits may be best understood not as a direct measure of time or cost savings, but rather as an increase in the *total welfare* experienced by the traveler. The most common measure of the social welfare derived from consumption is *consumer surplus*, which represents the cumulative excess of individuals' *willingness* to pay over the price that they *actually* pay. When this excess is summed over all consumers in the market, it is a measure of the total user benefits.

The consumer benefits resulting from the introduction of high-speed rail service may be quantified by estimating the *net change in consumer surplus* experienced by the users of the new system. This change in welfare occurs because of improvements in the level of service experienced by high-speed rail passengers relative to their previous mode (more frequent service, easier access, improved comfort, etc.). The welfare increase is equivalent to the dollar value of these service improvements, which can be estimated using the framework developed by Small and Rosen,[3] who first applied the theory of welfare economics to situations where consumers face a limited set of choices, such as among several travel modes.

An important advantage of using the Small and Rosen framework is that the user benefits or consumer surplus may be calculated in a manner directly consistent with the ridership demand forecasting process. Travelers' valuation of a service improvement is computed as the amount consumers would have to be paid to make them as well off after the improvement as they were before the improvement. This *compensating variation* may be computed using the utility functions of the diversion models for each market segment that were developed for the ridership forecasts (please refer to Section 4.8 for further detail). The change in utility or consumer welfare is scaled with the cost coefficient (equal to the marginal utility of money) for each market segment. The resulting dollar values are then multiplied by the high-speed rail patronage for the market segment to get the consumer surplus. Finally, the consumer surplus for all market segments is summed to provide the measure of total user benefits.

Proper calculation of user benefits is a critical component in the proper evaluation of any public infrastructure profit. Consumer surplus as a measure of user benefits is a widely-accepted and well known economic concept. Because the user benefits have such a large impact on the overall economic evaluation, special care was taken on this study to apply a peer-reviewed methodology which features the same level of technical sophistication as and is completely consistent with the ridership forecasting process. The high-speed rail user benefits are presented in Table 7.7.

[3]Small (1981).

Table 7.7 Net Economic Benefits Accruing to High-Speed Rail Users ($ 1996 million)

	Annual High-Speed Rail User Benefits			
	Basic System LA – SF		Basic System Plus Extensions	
Year	VHS	Maglev	VHS	Maglev
2005	$195	$336	$402	$649
2010	$212	$366	$437	$707
2015	$230	$399	$475	$770
2020	$249	$433	$515	$835
2030	$287	$501	$595	$965
2040	$325	$569	$675	$1,095
2050	$363	$637	$755	$1,225

Source: 2005-2020 – Charles River Associates.
2021-2050 – Wilbur Smith Associates.

7.3.2 Benefit Cost Methodology

To determine whether any of the envisaged high-speed rail investment alternatives are economically feasible, the costs of building each alternative are compared with economic benefits estimated to be attributable to each candidate high-speed rail system. This cost and benefit comparison yields three indicators of economic feasibility for each high-speed rail alternative:

- **Net Present Value** – Future year costs and benefits are discounted back to the base year (1996) using a 7 percent real (constant dollar) discount rate. The future stream of discounted costs is subtracted from the future stream of discounted benefits. When the sum of the discounted benefits is greater than the sum of the discounted costs, the "net present value" is positive and the high-speed rail system is deemed to be economically feasible. The net present value is the best indicator of economic feasibility.

- **Discounted Benefit/Cost Ratio** – The sum of discounted benefits divided by the sum of the discounted costs. When the result is 1.0 or greater, the high-speed rail alternative is considered economically feasible.

- **Internal Rate of Return** – Determines the discount rate at which the net present value difference between costs and benefits is zero. If the rate of return, expressed as a percentage, is equal to or greater than the discount rate (7 percent), then the investment is deemed to be economically feasible.

The measures listed above are widely-accepted means of assessing and comparing large capital projects. The methodology used for calculating benefits and costs, including the discount rate assumed, follow guidelines issued by the Federal Office of Management and Budget. These measures have been used extensively for decades in both the public and private sectors.

7.3.3 Benefit Cost Results

Table 7.8 presents cumulative costs and cumulative benefits over the period 2000-2050, discounted at the annual rate of 7 percent (as specified by the federal Office of Management and Budget). For example, the total present value of the highway mode savings for the VHS Basic System is $983 million. While benefits are estimated only through the year 2050, the high-speed rail system will still have some remaining economic value after that year. To account for this, a residual value is applied in the year 2050 as a negative cost. This residual value includes 100 percent of the right-of-way value and 30/75 of the line construction cost (45 years of operation on systems assumed to last 75 years).

Table 7.8 indicates that high-speed rail is expected to generate very significant economic benefits, ranging from $7.1 billion (VHS, without extensions), to $19.5 billion (Maglev with extensions). The extensions to San Diego and Sacramento nearly double the economic benefits.

Table 7.8 Total Discounted Costs and Economic Benefits (Year 2000-2050) ($ 1996 million)

	Basic System L.A. – SF		L.A. – SF Plus Extensions	
	VHS	Maglev	VHS	Maglev
Costs				
Capital Cost	$7,584	$10,735	$10,528	$14,697
Residual Value	(97)	(139)	(155)	(216)
Total Costs	**$7,487**	**$10,596**	**$10,373**	**$14,481**
Economic Benefits				
Other Mode Savings:				
Highway	$983	$1,085	$2,068	$2,307
Air	$2,882	$3,936	$5,133	$6,915
Conventional Rail	$259	$259	$485	$521
High-Speed Rail User Benefits	41,792	$3,112	$3,400	$5,541
High-Speed Rail Operating Surplus	$1,199	$2,252	$2,607	$4,190
Total Benefits	**$7,116**	**$10,645**	**$13,693**	**$19,473**
Net Benefits	**$(371)**	**$49**	**$3,320**	**$4,992**

Source: Economic Research Associates, (1996).

To properly analyze the various high-speed rail options, a life cycle approach was used whereby all costs and all benefits were estimated for each and every year through the year 2050. To determine whether the high-speed rail system is economically feasible, the costs must be compared with the benefits. This comparison is presented below and in Table 7.9 in the form of Net Present Value (NPV), Internal Rate of Return (IRR), Benefit/Cost (B/C) Ratio

Table 7.9 Economic Benefits/Cost Results (1996–2050 Life Cycle)

	Basic System L.A. - SF		L.A. - SF Plus Extensions	
	VHS	**Maglev**	**VHS**	**Maglev**
Net Present Value ($ Million)	($371)	$49	$3,320	$4,922
Internal Rate of Return (percent)	6.72%	7.03%	8.64%	8.79%
Benefit/Cost Ratio	0.95	1.00	1.32	1.34

Source: Economic Research Associates, (1996).

7.3.4 Sensitivity Tests

The benefit/cost analysis is based on a number of calculations, estimates, and assumptions. To test the sensitivity tests of the benefit/cost findings to these assumptions, eight sensitivity tests were conducted:

1. **Four Percent Discount Rate** – The overall test of economic feasibility was based on an Office of Management and Budget-sanctioned discount rate of 7 percent. This sensitivity test was used to see which high-speed rail system might be best at the lower discount rate of 4 percent.

2. **Ten Percent Discount Rate** – A higher discount rate makes economic feasibility more difficult to achieve. This higher rate was tested to see if any high-speed rail option might still be feasible.

3. **Capital Cost 20 Percent Less** – Recognizing that the high-speed rail capital cost estimates are preliminary in nature, the cost estimates were reduced by 20 percent for this test.

4. **Capital Cost 20 Percent Greater** – A more useful test is to increase all high-speed rail preparation and construction costs by 20 percent.

5. **Benefits 20 Percent Greater** – To test the possibilities that the estimates of benefits or ridership are low, a sensitivity test with higher benefit totals was conducted.

6. **Benefits 20 Percent Less** – Similarly, benefit estimates might be high. This sensitivity test was developed to account for this possibility.

7. **Ten Year Delay** – It is quite possible that high-speed rail will not be built and open for business by the year 2006. To test this possibility, all costs and all benefits were delayed by 10 years, to determine how such a delay might affect economic feasibility.

8. **Zero High-Speed Rail Operating Surplus** – This sensitivity test was conducted to test the break even scenario (operating costs equal to operating revenue).

The results of these sensitivity tests are summarized in Table 7.10 and below:

- The sensitivity tests do not change the general ranking of the four high-speed rail alternatives, except where the alternatives are infeasible (for example, at a 10 percent discount rate it is better for the economy to lose less).

- The high-speed rail system with extensions remains economically feasible under every test except the 10 percent discount rate. High-speed rail remains economically feasible even if the system costs 20 percent more to build, and even if economic benefits are 20 percent less than estimated.

- The basic Los Angeles-San Francisco system is only marginally feasible. The basic system returns a positive net present value only when a 4 percent discount rate, 20 percent lower costs, or 20 percent higher benefits are assumed.

Overall, the sensitivity tests indicate that high-speed rail is economically feasible over a reasonable range of assumptions and calculations. For example, the complete high-speed rail system has economic merit even if it were to cost 20 percent more than estimated, yield 20 percent less benefits, or is delayed by 10 years.

7.3.5 Benefit/Cost Findings

- **High-speed rail in California is economically feasible.** Benefit/cost ratios of 1.32 and 1.34 and positive net present values of $3.3 to $5.0 billion (life cycle, discounted) indicate a feasible undertaking. A constant price level rate of return of 8.6 percent to 8.8 percent is quite attractive. If future inflation were assumed to be 5 percent annually, the current dollar rate of return would be 13.6 percent to 13.8 percent – a good economic rate of return (the financial rate of return may be greater or less than this economic rate of return).

- **The basic high-speed rail system (Los Angeles – San Francisco only) is less feasible.** The more limited Los Angeles to San Francisco high-speed rail system (without the extensions) is only marginally feasible, with benefit/cost ratios of 0.95 to 1.00. The calculations show quite clearly that the system with the extensions is superior to building only the San Francisco-Los Angeles portion.

Table 7.10 Economic Benefit/Cost Sensitivity Test (1996–2050 Life Cycle)

	Basic System L.A. to S.F.		With Extensions	
Sensitivity Test	VHSR	Maglev	VHSR	Maglev
Net Present Value ($ Billion)				
4% Discount Rate	$6,814	$10,658	$18,387	$26,016
10% Discount Rate	(2,603)	(3,337)	(1,575)	(1,938)
Capital Cost 20% Less	1,146	2,196	5,426	7,932
Capital Cost 20% More	(1,884)	(2,098)	1,215	2,053
Benefits 20% More	1,054	2,178	6,059	8,886
Benefits 20% Less	(1,794)	(2,080)	582	1,099
Ten Year Delay	900	1,476	3,798	5,248
Zero HSR Operating Surplus	(1,570)	(2,202)	714	802
Internal Rate of Return (%)				
4% Discount Rate	6.72	7.03	8.64	8.79
10% Discount Rate	6.72	7.03	8.64	8.79
Capital Cost 20% Less	8.00	8.37	10.13	10.32
Capital Cost 20% More	5.76	6.03	7.53	7.64
Benefits 20% More	7.75	8.10	9.84	10.02
Benefits 20% Less	5.58	5.84	7.30	7.42
Ten Year Delay	8.30	8.52	10.57	10.58
Zero HSR Operating Surplus	5.78	5.78	7.37	7.30
Discounted Benefit/Cost Ratio				
4% Discount Rate	1.78	1.87	2.47	2.50
10% Discount Rate	0.59	0.63	0.81	0.84
Capital Cost 20% Less	1.19	1.26	1.66	1.69
Capital Cost 20% More	.79	0.84	1.10	1.12
Benefits 20% More	1.14	1.21	1.58	1.61
Benefits 20% Less	0.76	0.80	1.06	1.08
Ten Year Delay	1.24	1.27	1.72	1.71
Zero HSR Operating Surplus	0.79	0.79	1.07	1.06
Basic Feasibility Test				
Net Present Value ($ Billion)	($371)	$49	$3,320	$4,992
Internal Rate of Return (%)	6.72%	7.03%	8.64%	8.79%
Benefit/Cost Ratio	0.95	1.00	1.32	1.34

Source: Economic Research Associates, (1996).

- **There is little economic difference between VHS and Maglev.** Although a Maglev system will cost about 50 percent more than VHS, its economic benefits are also about 50 percent greater. There is no real difference in rates of return or benefit/cost ratios between VHS and Maglev. The benefit/cost ratios of 0.95 and 1.00 for the basic system, and 1.32 and 1.34 with extensions are so close as to be viewed as the same within each system.

- **The California economy will be better off with high-speed rail.** The net present value estimates represent the net economic value of high-speed rail for California through the year 2050. These values exclude the economic impacts attributable to the act of high-speed rail construction (money from outside of California used to build the high-speed rail system), firms that might be attracted to California due to the high-speed rail, development near high-speed rail stations, etc. According to this study's definition of net transportation efficiency benefits, the California economy will be better off by $3.3 billion with VHS is built or nearly $5.0 billion with Maglev.

- **There is an economic argument for high-speed rail in California.** Based on this economic impact analysis, California should build a high-speed rail system. The system will not only afford cost savings related to the existing intercity transportation modes but will improve the California economy as well.